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Effects Of Budworm Spraying On Wildlife Studied

It's 4:00 a.m. at the Moose River logging camp deep in the western Maine forest when the lights go on and the crews begin to stir. The breakfast call is issued soon after, and all know that a few extra minutes in the bunk can mean they don't eat until the "mid-day" meal at 9:30 a.m. in the field. As dawn slowly lights the camp, they assemble their gear and head out over rough logging roads for work sites located several hours away.

The five crews and their equipment are not what you'd expect in a lumber camp. The 25 men and women are biologists, not loggers. Instead of chain saws and axes, they are loaded down with insect nets, rubber rafts, hipwaders, generators and yes, even ducklings. All 25 are involved in a research program of the Maine Forest Service that is designed to assess the effects of the spruce budworm spray project on the Maine environment.

Six studies, some of which were started the previous summer, are being conducted simultaneously. Dr. Malcom Hunter, a University of Maine wildlife biologist, has been investigating the relationship of the budworm spray project to black ducks since the spring of 1979. Dr. Hunter has "imprinted" newly hatched ducklings so that they respond to him as they would to their mother. For 20 days last spring "Mac" and his assistants weighed imprinted ducklings each morning, then drove or carried them to a small woodland pond in a spray area and observed them until dusk, recording their food intake. As evening fell, Dr. Hunter called to the imprinted brood so they could be taken back to the camp, carefully reweighed and put to bed. Dr. Hunter's objective is to see if growth of the ducklings is affected because the chemical insecticide used in the budworm program kills a large number of other insects that are an important part of the ducklings' diet.

Hunter's team also studied the impact of reduced insect numbers on the growth of nestling chickadees and the feeding behavior of adult warblers. For the chickadee study they put up 160 nest boxes in April. In early May, three of the occupied boxes were equipped with movie cameras designed to photograph both the food delivered by the parents and a clock recording the times when parents entered the nest box. By linking the number and the frequency of the feeding visits, and weighing the nestlings daily, Dr. Hunter will be able to assess any changes in the parents' efforts to feed their young during budworm spraying.

Working with Dr. Hunter were four other research teams — three from the University of Maine and one private environmental consultant. Russ McCullough, a University of Maine fisheries biologist, and his co-workers trudged through the woods carrying electrofishing equipment to take fish samples each day by 7:00 a.m.

Like Dr. Hunter, McCullough located his study sites last winter, snowmobiling into remote areas and electrofishing until he found an adequate number of brook trout. The electrofishing gear consists of two probes that have an electric current flowing between them. The electric current temporarily stuns any fish within 1.2 to 1.5 m (4 to 5 feet). The fish then float to the surface where McCullough could scoop them into a bucket for examination. After examination, they are released unharmed. During the project, brook trout fry were examined for spray contamination and growth patterns. When not electrofishing, McCullough's team measured insecticide residues in the water and recorded the young trout's feeding behavior.

Joan Trial, an entomologist from the University of Maine, and her assistants placed 750 artificial leaf packs in six streams to discover what effects a reduction in leaf-shredding insects has on the stream ecosystem. The leaf packs were made up of 8 to 12 oak leaves stapled together and tied to a rock. The insects being studied, stoneflies, help speed the breakdown of organic materials such as leaves. Past environmental studies have shown these insects to be very sensitive to the budworm spray Sevin-4-oil. Ms. Trial is trying to discover how important the stoneflies are to a stream and how a stream might be changed by the loss of the insects.

Dr. Cassie Gibbs, another entomologist from the University of Maine, combined efforts with other researchers and continued her 3-year study of the effects of Sevin-4-oil in the aquatic environment.

Bruce Grantham, an independent environmental consultant, joined the University of Maine research teams to study "refugia." Refugia are upstream areas with relatively unaltered insect populations that could repopulate downstream areas where insect numbers may have been reduced by spraying. Grantham's research is expected to aid the Maine Forest Service in refining policies on the application of insecticides near streams.

Because insect activity is best studied at dawn and dusk, Grantham and his crew maintained an unusual schedule from mid-May to mid-June. Each morning they were in the field before daylight, wading into streams and gathering samples. Periodic samples will be taken until November.

The Maine Forest Service will spend \$195,000.00 for spruce budworm environmental studies this year, according to the Director, Kenneth Stratton. "Since the early 1970s, the Forest Service has funded research aimed at identifying the effects spraying may have on the environment. We will continue to pursue projects which show promise of helping us find new and better ways of protecting the forest resource with minimum environmental disruption."

Spruce budworm research reports are available from the Maine Forest Service, Department of Conservation, State House Station 22, Augusta, Maine 04333.

Ann Pistell — Information and Education Section
Maine Department of Conservation

Editors' Note

The Newsletter article "Use of Exclusion Cages in Population Studies in the Western United States" (Newsletter Number 13, November 1980) was contributed by Martha Brookes at the Pacific Northwest Station. Gladys Daines at the Northeastern Station originated the articles on shelterwood management and balsam fir utilization in Newsletter Number 11. We welcome these contributions from agency editors/information specialists and we are pleased to note that there are more on the way.

Professional Meetings

There follows a listing of professional societies and groups with our best information on dates and places of meetings scheduled through 1983. Agency/institutional administrators: please do not accuse us of promoting travel in this time of travel restrictions and tight budgets. Our intent is simply to alert Program investigators and managers to opportunities to report CANUSA accomplishments, and to schedule appearances of the CANUSA exhibit on request. For example, the joint meeting of our entomological societies in Toronto in 1982 is an ideal setting in which to feature a spruce budworms symposium. Any organizers out there?

Group	1981	1982	1983
Entomological Society of America			
National Meeting	San Diego, CA Nov. 29-Dec. 3	Toronto, Ont. Nov. 28-Dec. 2 (Joint with Ent. Soc. Can.)	Detroit, MI Nov. 27-Dec. 1
Eastern Branch	Philadelphia, PA Oct. 21-23	Hartford, CT Sept. 29-Oct. 1	Newcastle, NH Sept. 21-23
North Central Branch	Columbus, OH March 17-19	March	March
Pacific Branch	Oakland, CA June 23-25	June	June
Entomological Society of Canada	Banff, Alta. Oct. 5-9	Toronto, Ont. Nov. 28-Dec. 2 (Joint with ESA)	
Entomological Society of Quebec	Montreal, Que. October		
Society of American Foresters	Orlando, FL Sept. 27-30	Cincinnati, OH Sept. 19-22	Portland, OR Oct. 16-19
American Forestry Association	Santa Fe, NM Oct. 11-14	Cincinnati, OH Oct. 10-13	Sept.-Oct.

Group	1981	1982	1983
National Association of State Foresters			
National Meeting	Mobile, AL Oct. 4-7	October	October
Northeastern group	Bar Harbour, ME July 19-21		
Western group	Jackson Hole, WY June 21-23	May	May
Canadian Institute of Forestry	Halifax, N.S. October	Prince George, B.C. October	
American Association for the Advancement of Science	Toronto, Ont. Jan. 3-8	Washington, DC Jan. 3-8	Atlanta, GA Jan. 3-8
American Institutes of Biological Sciences	Bloomington, IN Aug. 16-21	State College, PA Aug. 8-13	August
International Congress of Plant Protection			England August
Northeastern Forest Insect Work Conference	Bangor, ME Feb. 24-25	Burlington, VT April	
Central International Forest Disease & Insect Work Conference	Minnesota Sept.-Oct.	Canada Sept.-Oct.	Wisconsin Sept.-Oct.
Western Forest Insect Work Conference	Banff, Alta. March 3-5	March	March
Northeastern Forest Pest Council	March	March	March
Western Forestry and Conservation Association	Portland, OR December	Seattle, WA December	
17th IUFRO World Congress	Kyoto, Japan Sept. 6-11		
Canadian Symposium on Remote Sensing	October		May
International Symposium on Remote Sensing of the Environment	April	April	April
Canadian Information Processing Society	May	May	May
Society for Invertebrate Pathology	Missoula, MT August		

Group	1981	1982	1983
International Committee on Regeneration of North Latitude Forest Lands	Prince George, B.C. Aug. 29-Sept. 2		

Working Group Meetings

Eastern and Western working group meetings were held in late October of 1980. Both groups changed the format of their meetings somewhat in order to better respond to the needs of the program. Both meetings depended heavily upon user group input, with resource managers forming a significant segment of the participants.

In the East the format included four special interest groups: tree mortality and growth loss; pheromones — their use in surveys and population manipulation; *Bacillus thuringiensis*; and aerial application technology. Some attended all sessions and others participated in only one or two. Mel McKnight and Chuck Buckner acted as co-chairmen for the 4-day meetings.

Tree mortality and growth loss assessment — Forty-seven attended this meeting to hear reports on impact assessment efforts and techniques employed in the Lake States, Maine, and eastern Canadian provinces. The suggestion was made that CANUSA should publish an annual summary of total budworm-caused tree mortality in all of eastern North America. However, the consensus was that while such an annual publication would have value, a summary at the end of the CANUSA Program would be more useful. Ed Kettela volunteered to spearhead this effort.

John Witter led a discussion on ground and aerial methods for assessing mortality and growth loss. Considerations of sample size and sampling intensity were reviewed.

Don Ostaff reported progress in this area in cooperation with Phil Gimbarzevski and Peter Kourtz using remote sensing techniques. Plans are to continue the development of this method, either in the Cape Breton Highlands or New Brunswick.

Pheromones: Survey and control — After reporting on recent pheromone-related research, 53 participants turned their attention to the two potential uses for pheromones; control or suppression of SBW infestation, and monitoring of preoutbreak populations. For various reasons, a male confusion/mating suppression trial in Maine during 1980 was unsuccessful. Still, some cooperators believe that further efforts at mating suppression should be made next year. Further talks relating to pheromones for survey/monitoring work are expected to result in some cooperative field testing during 1981. Chris Sanders will act as coordinator and consultant.

Bacillus thuringiensis — Preliminary analysis of 1980 core test data showed that results were variable from one test location to another, with the most satisfactory control achieved in Wisconsin. Factors that affected *B. t.* efficacy in other locations were (1) a hard frost before treatment

in New Hampshire, (2) frequent rainy periods in Maine during the test, and (3) "too late" treatment (plus other difficulties) in Arizona. A composite report on results at all locations will be available this winter. There were 68 attendees at this discussion.

We also learned from Norm Dubois that his *B. t.* strain screening work has not yet identified a more potent strain of *B. t.* for budworm control than the currently used HD-1 strain. Also, there seemed to be a rather general feeling that 19.8 BIU/ha (8 BIU/acre) was a borderline minimum dosage and that better results could be obtained with higher dosages and multiple or split applications. Multiple applications are common in chemical insecticide operations. This approach will be explored in 1981. There was general consensus that a dosage response curve was needed. This should be a CANUSA priority in 1981.

Chet Himel reported on his *B. t.* formulation research, which involves encapsulation of the spray droplets as a means of extending their activity life. Ozzie Morris tried again to get from users a clear statement of precise criteria for acceptable protection with *B. t.* sprays.

Wladimir Smirnoff showed his video-tape of *B. t.* as a budworm management tool.

Aerial application technology — At this meeting, 57 participants listened to Jack Armstrong describe the advantages of the portable Heath Kit weather monitoring unit, which he has field tested. Several of these units have been purchased by various research units and may find wider usage in field experimentation next year.

The group was not able to identify any new potential chemical insecticides to recommend for CANUSA development. Several chemicals are already registered and available for use, and some are in the final stages of testing.

There is a definite need for improvement in the technology of applying insecticides or controlling drift. Dr. A. Sundaram reported her work and her approach in formulation physics. The problem analysis presented will provide a framework for research in this area.

CANUSA Program Management Meetings In Ottawa

The second annual CANUSA Program Managers Meeting was convened in Ottawa on December 2-4, 1980. The entire CANUSA management staff, with the exception of Tom Flavell from CANUSA US West and a representative of the management staff of the Petawawa National Forestry Institute, were present for the 2 1/2 days of deliberation. A number of current topics were discussed: joint registration of insecticides (see article in this issue); the human health aspects of budworm control operations (a highly sensitive issue of concern to resource managers); application technology; transition planning; the proposed joint symposium to display the scientific outputs of the program; and a number of other items of concern to management.

Results of this meeting will appear in the revised Activity Schedule, in the detailed program plans of all participating establishments, and in the agendas of the



Some of the participants at the working group meetings.

Joint Planning Unit and the Joint Policy and Program Council. The next meeting will follow the 1981 working group meetings and it will probably have a western locale, possibly Portland, OR.

Joint Registration Of Insecticides

The ad hoc committee for data sharing and joint registration met December 2, 1980, in a concurrent session with the annual CANUSA Program Manager's meeting at Canadian Forestry Service (CFS) Headquarters in Hull, Quebec. The program managers for forest protection from the CFS Research Centres, the CANUSA-East and CANUSA-West program managers, and Len Ritter of the Canada Department of Health and Welfare were also present.

The purpose of the session was to bring all participants up-to-date on the work of the committee and to discuss the status of committee actions and future steps to be taken. One of the major items of discussion was the selection of a candidate insecticide to be used as a test case in the development of effective data-sharing procedures and joint registration in Canada and the United States. "Priority" candidate insecticides considered for a joint registration effort were identified by earlier committee action in a document entitled "Status of Insecticides for Suppression of Spruce Budworms."

The three insecticides felt to be the most likely candidates for joint registration action were chlorpyrifos-methyl (Reldan), methomyl (Lannate), and permethrin. The group selected chlorpyrifos-methyl for testing the joint registration process. Fred Honing and Jack Armstrong agreed to follow up on this decision. Honing will contact Dow Chemical Company to determine if the company intends to develop chlorpyrifos-methyl for forestry uses in the United States as well as in Canada.

It was also recognized that since permethrin and methomyl also merit consideration for joint registration, options toward this end should be kept open. Registration packages for methomyl have been submitted for review in both countries, making this material a potential candidate for joint registration.

Several examples of new formulations of presently registered insecticides were discussed. As improved formulations are developed, data sharing would also expedite getting modified labels in either Canada or the United States.

The main points stressed by the committee cochairmen at the close of the meeting were (1) the need to maintain close contact for effective exchange of data and information between the two countries; (2) the need to keep abreast of the intentions of insecticide producers with regard to supporting specific products of interest to CANUSA; (3) the increasing pressure for federal agencies to step into the role of registrant, especially for the biorationals; and (4) the need to maintain close contact with regulatory agencies to help keep abreast of problem areas and regulatory developments.

New CANUSA Display and Slide-Tape Show

A new CANUSA display has been constructed to help convey our message to the public. This streamlined version is the brainchild of Bob Talerico and Bruce Denyer and uses easily assembled, stacking, triangular panels that show a series of photos or diagrams and explain the CANUSA program. It comes in two large but manageable carrying cases and there are English and French versions. Previewings at strategic places across the country have had a good reception. The display can be used at meetings or for public viewing in a suitable location. Contact Bob [(215) 461-3015, FTS 489-3015] or Bruce [(613) 997-1684] if you would like to use one or both of these displays.

CANUSA-West has produced a very interesting slide-tape show explaining the western components (Canadian and American) and their relationship to the program. Contact Jim Colbert [(503) 231-2034, FTS 429-2034] for information on its availability.

Editors Note

The Newsletter item "Use of Chemical Insecticides against the Spruce Budworm in Eastern Canada" (No. 11, July 1980) implies that operational spraying in the 1950s commenced with "an ambitious philosophy of 'extermination' . . ." According to a number of authorities, this statement misrepresents spraying programs in New Brunswick from their inception in 1952.

Dr. R.E. Balch who was the officer-in-charge of the Forest Insect Laboratory at Fredericton in 1952 stated "The objective was not to halt the outbreak but to prevent the trees from being killed by protecting them from complete defoliation until the outbreak subsides."

This view was also shared by the late B.W. Flieger, manager of the program on behalf of the Province of New Brunswick and industrial sponsors.

More recently Dr. M.L. Prebble in an intensive review of forest protection programs in Canada elaborated upon this point, stating that the spraying program in New Brunswick was based upon the philosophy of maintaining the life of the trees until harvesting could be accomplished. And finally, Dr. F.E. Webb has pointed out that the design of the hazard rating system that he developed for use in New Brunswick during the early period of the spray program was based upon this objective.

The editor would like readers to be aware of these differing viewpoints and that the CANUSA Newsletter tries to reflect these varying opinions but that they do not necessarily reflect the opinions of the CANUSA program.

CFS Appointment

D.R. (Ross) Macdonald, a former Deputy Director of the Pacific Forest Research Centre, was appointed Director of PFRC effective July 1980. Immediately prior to this appointment Ross was Director of Forest Protection at Canadian Forestry Service Headquarters in Ottawa since 1977. In this position he was responsible

for CFS research across the country on pest and disease control, which includes CANUSA, and forest fire control.

Scientist had Art Show

Dr. W.A. Smirnov, who is involved in research on the use of *Bacillus thuringiensis* for the control of spruce budworm at the Laurentian Forest Research Centre, recently revealed another one of his talents. In early February Dr. Smirnov showed a series of his paintings at the National Museum of Natural Sciences in Ottawa. The exhibit was entitled "Forest Flora of Quebec" and included paintings of wild forest flowers, as well as floral emblems of the provinces.

New Program Manager At CANUSA-West

Ronald W. Stark has been named by the Pacific Northwest Station at Portland, OR, as the Program Manager for CANUSA-West. He succeeds Max McFadden who was promoted to Forest Service headquarters in Washington, D.C. Ron will retain his position as professor of forest entomology at the University of Idaho, a position he has held since 1978 when he returned to the University from a 1-year stint as Deputy Program Manager for the USDA Douglas-fir Tussock Moth Program. Ron is well-known in the forestry communities of both the United States and Canada, having served as graduate dean and coordinator of research at the University of Idaho, professor of forest entomology at the University of California at Berkeley, and research scientist in forest biology with the Canada Department

of Agriculture at Calgary. We are especially pleased to have Ron join the CANUSA Program and we expect to reap the benefits of his wealth of experience.

CANUSA Information Coordinator Named

In early March, Janet L. Searcy joined the CANUSA Program as writer/editor in the Program Leader's office in Washington, D.C., to assist with information and technology transfer activities. She comes to CANUSA from a similar position in the USDA Expanded Southern Pine Beetle Research and Applications Program (ESBRAP). Janet's appointment is in response to the need recognized by the CANUSA Joint Policy and Program Council (JPPC) to provide more and better information on the role of forest protection in resource management. We welcome Janet to the Program and look forward to more and better "news" about CANUSA.

Press Clippings

PORT HAWKESBURY, N.S. (CP) — The Nova Scotia Forest Industries Ltd. pulp and paper mill ended its winter woodcutting Friday, laying off 220 unionized wood workers and eliminating income for about the same number of woodlot owners and logging contractors.



The CANUSA Display on exhibition in a hotel lobby.

The layoffs are the first financial casualties of Cape Breton's spruce budworm infestation which, ironically, has caused a temporary surplus of pulpwood because of a cleanup effort aimed at getting rid of budworm-killed and dying wood before it rots.

The reduction was "inevitable and we'll just have to live with it," says Edward Gravefell, the Atlantic vice-president of the Canadian Paper Workers Union.

In an interview from his home in Truro, N.S., he said the oversupply of budworm-damaged wood could have been prevented if the forests had been sprayed seven or eight years ago.

Hollis Routledge, assistant woodlands manager for Nova Scotia Forest, announced Nov. 20 the company was reducing logging operations for the winter because it would use its inventory of budworm-damaged wood for production of pulp.

The company made an agreement in 1977 with the Nova Scotia government to cut and store 360,000 cords of budworm-damaged wood.

Routledge said in November the company wants to work away at its oversupply of the wood until normal production resumes in the spring.

Gravefell said about 220 unionized employees and about the same number of private woodlot owners and contractors would be affected by the company's action.

The union representative said most companies suspend logging operations from December until the spring, but Nova Scotia Forest, a Swedish company which believes in full employment, had previously operated on a year-round basis.

The spruce budworm in Quebec — The Quebec Department of Energy and Resources considers that the biological product *B.t.* constitutes, at the moment, the best alternative to chemical products presently used to fight the spruce budworm. But when considering the actual difficulties of application of *B.t.* and its cost, which is 4 times higher than that of chemical products, the Department of Energy and Resources does not foresee using it in greater proportions than in the past during the course of the spraying campaign of 1981. The Department estimates however that it is useful and necessary to pursue research on this biological product but that, for now, its use on a large-scale operational basis is not indicated.

(Press Release — Quebec Department of Energy and Resources — Oct. 27, 1980)

Spraying of New Brunswick Forests will Continue Next Year — The spraying of New Brunswick forests to kill spruce budworm will continue next year but on a more selective basis, says Natural Resources Minister J.W. Bird. Bird said this week in his annual report on the 1980 spray program that new mapping and spray techniques will allow the anti-budworm spray to be concentrated in areas where it will do the most good. "Up to now we

have not had the forest management tools to make this possible." The minister said the mapping will make it possible to spray specific stands of trees instead of spraying everything in a designated block.

The province has been spraying to kill budworm — a voracious insect that attacks balsam fir and other softwoods used to make paper — since the early 1950's. Despite the spray, hundreds of thousands of acres of trees have been destroyed by the insect. The cost per acre of selective spraying will probably be higher, Bird said, but it will be more efficient because it will not waste insecticide on trees that are already dead or that are not facing a high risk of budworm damage.

(Halifax Chronicle Herald — October 16, 1980)

Recent Publications

A recent publications list has revealed some interesting new reports from the CFS Centres and Institutes. These include:

"Damage to black spruce cone crops by the spruce budworm" by H.O. Schooley. Information Report N-X-187. This report is available from the Newfoundland Forest Research Centre, Canadian Forestry Service, Building 304, Pleasantville, St. John's, Nfld. A1C 5X8.

"Condition du sapin et de l'épinette blanche dans la région du Parc des Laurentides en 1979 face à l'épidémie de la Tordeuse et prévision des pertes" by J.R. Blais. Information Report LAU-X-43. To obtain copies of this report, write to the Laurentian Forest Research Centre, Canadian Forestry Service, 1080 Route du Vallon, P.O. Box 3800, Ste. Foy, Quebec G1V 4C7.

"Forest pest conditions in the Maritimes in 1979 with an outlook for 1980" by L.P. Magasi, Information Report M-X-106, and "Aerial spraying of spruce budworm moths" by C.A. Miller et al., Information Report M-X-110, are available from the Maritimes Forest Research Centre, Canadian Forestry Service, P.O. Box 4000, College Hill, Fredericton, N.B. E3B 5P7.

The Forest Pest Management Institute, Canadian Forestry Service, P.O. Box 490, 1195 Queen St. East, Sault Ste. Marie, Ont. P6A 5M7 will provide copies of the following reports:

"Inoculation of the spruce budworm cell cultures with microsporidian, *Nosema whitei*" by G.G. Wilson and S.S. Sohi. Report FPM-X-24.

"Dosage-effect studies on the impact of permethrin on trout streams" by P.D. Kingsbury and D.P. Kreutzwieser. Report FPM-X-31.

"The environmental impact of nonyl phenol and the Matacil® formulation. Part I: Aquatic ecosystems" by S.B. Holmes and P.D. Kingsbury. Report FPM-X-35.

"Cessna Ag-truck calibration trials for the dispersal of aqueous formulations of *Bacillus thuringiensis kurstaki* in Newfoundland, 1979" by A.P. Randall et al. Report FPM-X-38.

"Persistence of microsporidian in populations of the spruce budworm and forest tent caterpillar" by G.G. Wilson. Report FPM-X-39.

And other publications available:

M.M. Czapowskyj, L.O. Safford, and R.D. Briggs.

1980. "Foliar nutrient status of young red spruce and balsam fir in a fertilized stand." Forest Service Research Paper NE-467, USDA Forest Service, Northeastern Forest Experiment Station, 370 Reed Road, Broomall, PA 19008.

"The land-grant legacy: Research for all Minnesotans". (Page 20 describes the role in CANUSA). Agriculture Experiment Station, University of Minnesota.

J.R. Carrow, S.A. Nicholson, and G.M. Howse.

1980. "Spruce budworm spraying in Ontario." Forest Resources Branch, Pest Control Section. Ontario Ministry of Natural Resources, Whitney Block, Queen's Park, Toronto, Ont. M7A 1W3.

"Forest Management, Prevention, Protection."

Department of Natural Resources, Fredericton, N.B. E3B 5H1

Bider, J.R., and G.A. Brocher. 1980. "Effet d'une pulvérisation expérimentale d'aminocarb (Matacil 1.4 "OSC") sur l'activité des populations animales terrestres." Min. des Ressources Renouvelables, Collège Macdonald de l'Université McGill, Ste-Anne-de-Bellevue, Québec H9X 1C0.

André Ahern. 1980. "Mesures biologiques à l'impact du Matacil 1.4 OSC en eaux courantes." Bio-Conseil inc., Québec.

P. Couture, M. Lambert, S.A. Visser. 1979. "Effets toxiques des insecticides fenitrothion et Matacil sur le phytoplancton et le zooplancton." INRS-Eau, Université du Québec, C.P. 7500, Sainte-Foy, Québec G1V 4C7.